fashion against the existence of more than six principal planets :—

" Or si quelqu'un demande, pourquoy il n'y a que six orbes des Planettes, Keppler respond :—Parce qu'il ne faut pas qu'il y ait plus de cinq proportions, tout autant qu'il y a de corps réguliers és Mathematiques, dont les costez et les angles sont esgaux les vns aux autres.—Or six termes accomplissent le nombre de ces proportions ; et par conséquent il n'y peut auoir que six principales Planettes."

Could anything be more convincing? Perhaps, after all, Uranus and Neptune are mere *simulacra,* will-o'-the-wisps contrived by Satan to deceive a reprobate race of astronomers no longer faithful to the great principles of analogy.

We have the authority of the Reverend François Chevillard (1667) for believing that mathematicians are (or should be) born under the sign of the Twins. He says :—

" *Les Iumeaux.*—Ce signe rend son homme beau, misericordieux, sage, ingenu, libre, vn peu menteur, coureur et voyageur, mediocre en commoditez, assez fidelle pour estre Intendant des Finances, propre aux Mathematiques, aux Loix, et à l'Arithmetique, sçachant dissimuler sa cholere, mais il sera pour courir danger vers l'âge de trente-deux ans ou du feu, ou du fer, ou de la morsure de quelque chien. . . ."

Here is something more properly mathematical. John Abraham (1607) gives the product $6757 \times 346 = 2337922$, and after explaining the test by " casting out the nines," proceeds as follows :—

" Et d'autant que la preuue de 9 n'est si certaine que le contraire ou la preuue de 7 (*sic*). Nous auons fait la preuue par 7. Et pour ce faire faut chasser les 7 dizaines de la somme à multiplier, sçauoir de 67 restent 4 de 45 restent 3 et de 37 restent 2 qu'il faut poser à l'un des bras de la croix " (that is, the cross used in the old-fashioned way of casting out the nines : but Abraham's cross is like a big +), " puis en la forme susdite faut aussi chasser les 7 du multiplieur, sçauoir de 34 restent 6 et de 66 restent 3 qu'il faut poser à l'autre bras de la croix, et multiplier les deux figures l'vne par l'autre, sçauoir 2 fois 3 sont 6 qu'il faut poser sur le haut de la croix et pour la fin de la preuue faut chasser les 7 des 2337922 de 23 restent 2 de 23 restent encores 2 de 27 restent 6 de 69 restent 6 de 62 restent 6 et encores des 62 restent encores 6 qu'il faut poser au bras de la croix."

It will be observed that this amounts to finding the least positive residues of the factors with respect to the modulus 7, and comparing their product with the residue of the product of the given numbers. The residues are found by actual division, not by any special rule ; curiously enough, it does not appear how the author found the 9-residues for the other test. No proofs are given to justify the process in either case.

The second part of Mr. Maupin's book (p. 160 to end) deals mainly with the notes of Albert Girard to the mathematical works of Stevinus. Both these men were very competent mathematicians, and a study of their work is very instructive. In their day, the science of mathematics was but little advanced beyond the stage at which it had been left by Pappus, Diophantus, and Ptolemy ; the notation of analysis was still very imperfect ; the methods of analytical geometry and infinitesimal calculus, as we now know them, had not

been invented ; the prevailing style of demonstration, as it appears to a modern reader, was both involved and diffuse. But the times were ripening for the great discoveries of Newton, Descartes, and Leibniz ; and if, as compared with the achievements of their immediate successors, the work of men like Stevinus seems poor and insignificant, we must remember that the work of these humble pioneers was probably more important than appears at first sight. No one who has studied the history of mathematics can have failed to see how advance in the subject has accompanied improvement in notation. Now the essential features of modern notation are due to the mathematicians of the earlier part of the seventeenth century ; and their service in devising it is really considerable. Besides this, they were the teachers of the younger mathematicians of their time ; and we may not unfairly credit them with having done nothing to spoil and something to stimulate the minds of men with greater genius than their own.

The ingenuity of some of these old worthies, especially in diophantine analysis, is really remarkable, and it is not always easy to see precisely their method of procedure ; for, after the manner of their time, they publish results without demonstrations. Some very curious results obtained by Girard (pp. 203-9 of Mr. Maupin's book) seem to show that he was acquainted with the reduction of a quadratic surd to a periodic continued fraction ; thus he obtains $1039681/328776$ as an approximate value for $\sqrt{10}$, and this rational fraction is, in fact, the eighth convergent to the infinite continued fraction which represents $\sqrt{10}$.   G. B. M.

ASTRONOMY FOR EXPLORERS.

Grundzüge der astronomisch-geographischen Ortsbestimmung auf Forschungsreisen. By Prof. Dr. Paul Güssfeldt. Pp. xix + 368. (Braunschweig : Vieweg und Sohn, 1903.)

AS the field of the geographical explorer daily narrows, so do the number and excellence of books dealing with geographical exploration continually increase. The book under review treats of the determination of time, latitude and azimuth with a transit theodolite, and the methods described are the simplest in use by the explorer ; it will serve, however, as an introduction to field astronomical methods generally.

The author leaves nothing unexplained, and commences with elementary definitions of number and quantity. A quarter of the book deals entirely with elementary arithmetic, algebra, trigonometry and analytical geometry. This is, perhaps, an excess of thoroughness ; for the explorer in most cases wants to get to business as soon as possible, and if he has not previously obtained a knowledge of the elements of these matters, he is more than likely to be content to use accepted formulæ without investigation, so that it is not quite clear for what class of reader the book is written.

It appears from the publishers' preface that Dr. Güssfeldt has had considerable experience of field

astronomical methods, having spent some ten years exploring in tropical Africa, Egyptian deserts and in the Andes of Chile and Argentina. The methods described are sound and practical, and taking the book as a whole, it will undoubtedly serve well as a course of astronomical study for those explorers who can afford time to read it.

But the day of the explorer is nearly over, and it is very desirable to substitute topographical for exploratory methods wherever possible. This is actually being done at the present moment on the Gold Coast, where Major Watherston is making a topographical survey by means of long rigorous traverses controlled by azimuths. In difficult countries where rapid triangulation is impossible, this system should always be adopted. As regards the perennial difficulty of the initial longitude, it is not always realised that we have now a series of well determined longitudes throughout the whole length of Africa, that there has been a great increase in the number of telegraph lines in that continent, and that wireless telegraphy promises to be of vast assistance in the determination of longitude differences of quasi-geodetic accuracy.

As this book is no doubt primarily intended for German students, it is worth while noting that the German colonial empire throughout the world has an area of about one million square miles, and that the largest single block of German territory is German East Africa, with an area of less than 400,000 square miles. It is in the long run cheaper to survey such a country by topographical rather than by rough astronomical methods, and the results are far more trustworthy, topographical work including the determination at wide intervals of zenith telescope latitudes and telegraphic differences of longitude. It is believed that the German authorities are fully alive to the importance of these considerations, as may be inferred from the excellent work of Captain Hermann and Dr. Kohlschütter in East Africa, and from the recent boundary surveys in Togoland.

The importance of purely astronomical exploration diminishes yearly, and though it will be some time before the astronomical explorer becomes extinct, the scope of his usefulness grows continually less; his last home will perhaps be in Central Asia, in Brazil, or at the Poles. Meanwhile, he will find Dr. Güssfeldt's an excellent text-book in which to study elementary field astronomical methods, but he should only employ these when topographical methods are impossible.　　　　　　　　　　　　C. F. CLOSE.

OUR BOOK SHELF.

The Tutorial Physics. Vol. ii. *Higher Text-book of Heat.* By R. Wallace Stewart, D.Sc. Pp. viii + 396. (London : W. B. Clive, 1903.) Price 6s. 6d.

THIS is a new and considerably enlarged edition of a book which we have previously noticed (December 21, 1893). We then declared our belief in the writer as one capable of stating with all clearness and necessary accuracy the various laws, and of showing their practical application by means of appropriate examples. In its present form, he appeals to a more advanced class of student than hitherto; and the question arises

whether the accuracy which was sufficient in an elementary statement is adequate in a more advanced exposition. With regard to the main part of the volume, we answer in the affirmative. The author has evidently been at great pains to secure lucidity and simplicity without a sacrifice of precision; and we cordially recommend the book to those who are willing to use it rightly. By this last phrase we mean to imply that it should be read to the accompaniment of prolonged work in the laboratory under the personal guidance of an efficient teacher. Granted this accompaniment, we think the book will be very helpful to those who are not taking physics as a principal subject of study, and who therefore do not wish to be confused by the bewildering detail and complication which larger treatises supply.

In a few places the above commendation must be qualified. On p. 244, Dulong and Petit are stated to have " found that for a given excess of temperature the rate of cooling depended not only on the temperature of the body, but also on that of the enclosure." That stumbling-block of expounders, the Joule-Thomson experiment, trips up the author repeatedly; though we readily admit that he goes straight on the whole. For example, on p. 272 it is declared to involve no performance of external work; on p. 281 the amount of external work done is expressed in the equation; on p. 382 the work is once more declared to be altogether *internal.* The first word on p. 283 should be *increase.* not *decrease.*

Vergleichende Anatomie der Wirbelthiere. Fünfte, vielfach umgearbeitete und stark vermehrte Auflage des " Grundriss " der Vergl.-Anatomie der Wirbelthiere. Von Dr. Robert Wiedersheim. Pp. xix + 686. (Jena : Gustav Fischer, 1902.) Price 16. marks.

ALTHOUGH in the title of the present work the word " Grundriss " is subordinated, the book is the fifth edition of that originally so named. Its second edition of 1888 replaced the author's Lehrbuch (1882 and 1886), and its third, of 1893, which formed the basis of the second edition of an English translation, was practically a new book. In this, certain modifications were first introduced which have characterised all subsequent editions, including the present one, in which the method of treatment remains unchanged.

The most marked advance in the book under review is the addition to eight of the nine sections of a series of short *résumés,* which materially enhance the value of the work, in the past a book of reference only.

In his preface the author enumerates fifteen subjects which have been especially modified and extended, chief among them the morphology of the head-skeleton, as lately determined by Gaupp. There are many minor curtailments and rearrangements in various parts of the book, and the recognition of the work of Milani and Häcker on the reptilian lung and avian larynx, of Paulli on the nasal labyrinth, of Budgett on the external gills of Gymnotus, of Oppel on the alimentary viscera, of Strong on the metamorphosis of the cranial nerves, and Bles on the pori abdominales, is sufficient to show that anatomists of all nationalities have been duly recognised, and that the book is up to date.

There are in all 711 text-figures, grouped to form 379 sets, and there is still the single coloured plate, designed to render clear the changes undergone by the cranial nerves in the passage from the aquatic to the terrestrial state. The bibliography, so largely the secret of the popularity of past editions, now reaches the appalling limit of 120 pp. In using this record'